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Publication date:
2014

Document version
Early version, also known as pre-print

Event-related potentials reveal increased distraction by salient global objects in older adults

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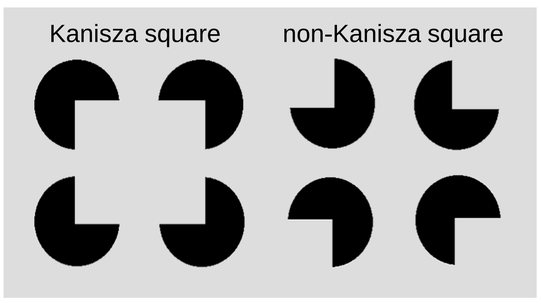
Introduction

• **Age-related visual decline** affects older individuals' perception and their interaction with objects in the environment (Madden, 2007)

• An **inhibitory deficit** has been suggested to cause age-specific difficulties (Hasher & Zacks, 1988): Older individuals have problems to select relevant visual information when salient distracting information is present

• A highly salient visual object is the **Kanizsa figure** (Kanisza, 1976):



• **Global precedence**: The global object representation induced by the figure is preferentially processed relative to configurations composed of physically similar local elements (Conci et al., 2007)

→ The difference in salience between Kanisza- and non-Kanisza figures is purely phenomenological (i.e. not caused by physical differences)

Methods

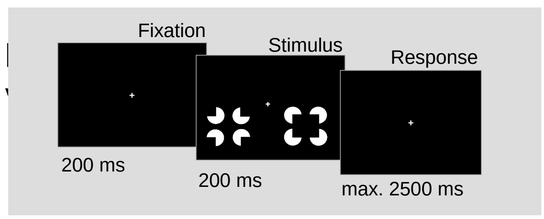
Participants

N=24, 12 younger and 12 older
Screening of older participants:

• no history of chronic somatic, psychiatric, and neurological diseases (self-report)

• no signs of beginning dementia (all scored ≥27in the Mini-mental state examination; Folstein & Folstein, 1975)

• Adequate visual acuity (all 0.63; Snellen, 1963)



Global Task:
• Selection of the Kanisza-figure, ignoring the non-Kanisza figure

Local Task
• Selection of the non-Kanisza-figure, ignoring the Kanisza-figure

Statistical Analyses

Mixed ANOVAs were run on
• Reaction times (RT)
• Error rates (Error%)
• Z-transformed reaction times (zRT)
• ERPs and ERLs (see Table above)

with the factors
• Task (global, local) - within-subjects
• Age (young, old) - between-subjects
• Electrode (PO7, PO8) - within-subjects, only for ERPs

Interactions were followed-up by separate ANOVAs and t-tests

Approach & Hypotheses

• We manipulated the phenomenological salience of target- and distracter-stimuli in a visual selection task using Kanisza- vs. non-Kanisza stimuli

• We measured event-related potentials (ERPs) and lateralizations (ERLs), to investigate age differences in target- and distracter-processing on several perceptual and attentional processing stages (Conci et al., 2011; Luck, et al., 2000; Töllner et al., 2011; Forthier-Gauthier et al., 2012; Wascher & Beste, 2010)

• **Visual P1 and N1:** Visual sensory encoding and discrimination

• **Posterior Contralateral Negativity (PCN)**: Spatial allocation of Attention

• **Positivity Posterior Contralateral (PPC)**: Salience-related processing

• We expected that a general performance decline in older age would be reflected in age-dependent (task-independent) ERP modulations (ME Age)

• We assumed that potential qualitative age differences – such as impaired inhibition of irrelevant global shape information – may become manifest in over-additive effects of global-local task conditions on age differences in the ERPs (Age × Task interaction)

EEG Recording and Processing

• 64 Ag/ AgCl electrodes, 10-10 system
• SR 1000Hz; 0.1-100 Hz BP-filter
• Online reference Cz; offline re-referenced to mastoids
• ICA-based correction of eye blinks and movements
• Epochs of -200 – 800ms, pre-stimulus baseline correction
• Exclusion of epochs containing artifacts (± 60 µV, voltage step <50 µV, activity <0.5 µV within 500 ms)
• ERLs = ERPs contra-minus-ipsilateral to the target location

	Time (in ms)	Measurement (at PO7/PO8)
P1	75-125	ERP mean amplitude
N1	150-200	ERP mean amplitude
PPC	150-200	ERL mean amplitude
PCN	250-500	ERL peak amplitude & latency

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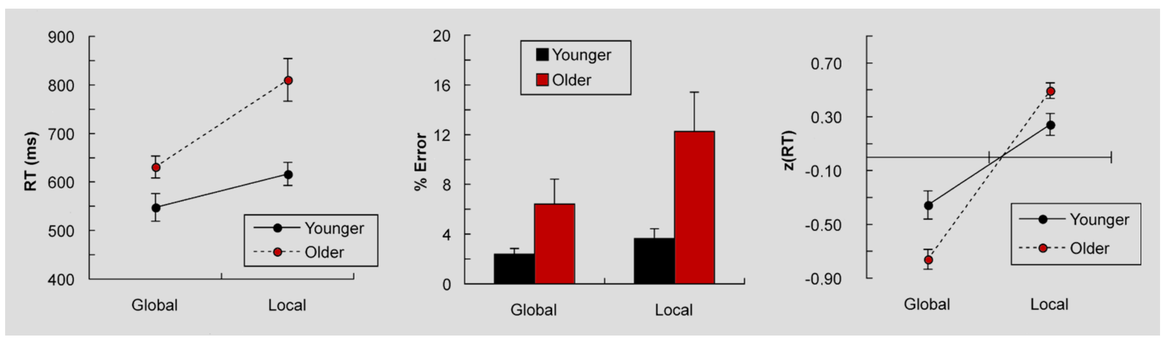
This research was conducted at the General & Experimental Psychology, LMU Munich, funded by the DFG Excellence Cluster EC 142 "CoTeSys" and DFG research group FOR480 to H.J.M.. I.W. received a scholarship from the Bavarian Elite Fund (BayEFG).

Results & Discussion

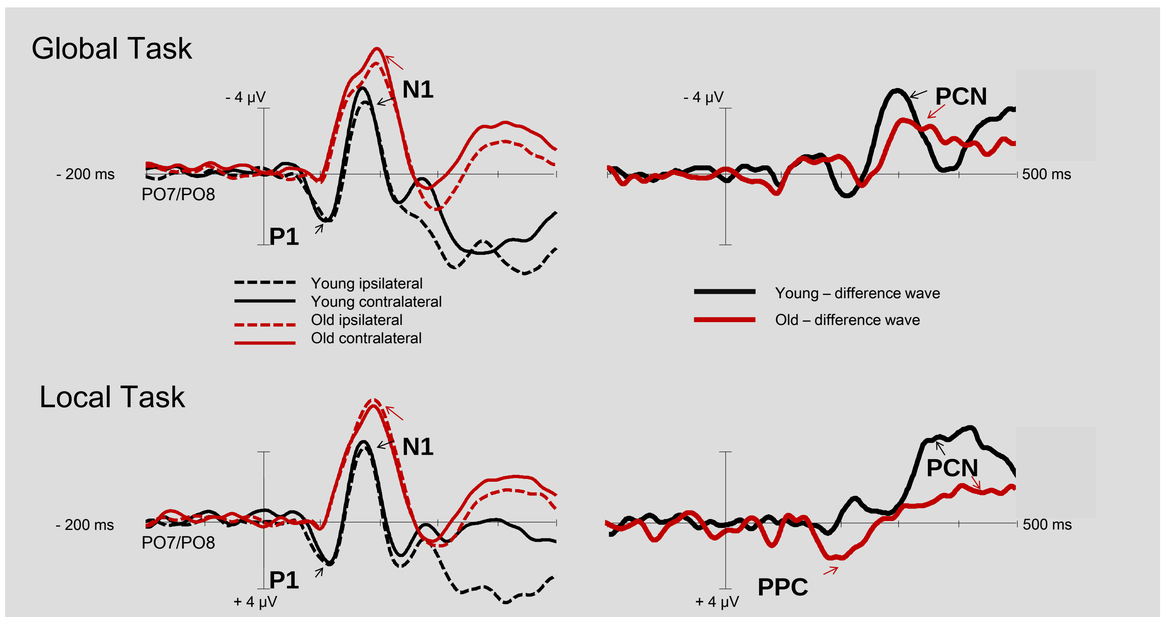
Behavioral Data



Age-related decline
• Older participants responded slower and less accurate and than younger participants
(ME Age on RT and % Error; both p<.025)

Global precedence
• Slower and less accurate responses in the global as compared to the local task across age groups
(ME Task on RT and % Error; both p<.05)

Increased global precedence with age
• The global processing advantage, i.e. faster responses to global relative to local targets, was stronger in the older than the in the younger group, independent of generalized slowing
(Task × Age on RT and z(RT), both p<.02)



Aging affects **sensory coding**; this may impede an **early processing distinction** between global and local stimuli

• The **P1** was more pronounced for younger than older participants
(ME Age, p=.01)
• Only in the younger group, the **P1** was larger in the global than in the local task
(Age × Task: p=.06; follow-up: ME Task (global>local) young: p=.01; old: p=.84)

Visual discrimination efficiency is reduced in older age
• The **N1** was enhanced for older relative to younger participants
(ME Age: p<.05)

Salient, **irrelevant**, **global objects** attract older individuals resources
• Only older participants showed a **PPC** in the local task, i.e. a negative ERL to the global distracter
(Age × Task: p<.05; follow-up: ME Task [local>global]; old: p<.003; young: p=.5)

Spatial allocation of attention is slowed in older age, and - independent of age - speeded for selecting Kanisza (relative to non-Kanisza) squares
• The **PCN** was reduced and delayed for older relative to younger participants
(ME Age: both F(1,22)=4.5 p<.05)
• The **PCN** peaks earlier in the global compared to the local condition
(ME Task: F(1,22)=8.96; p<.007)

Summary & Conclusions

• Age-related visual decline originates at multiple stages within the information-processing stream: sensory encoding (P1) and discrimination (N1) of objects is affected, and allocation of focal attention to objects in space (PCN) is slowed

• Beyond general decline, older individuals have a specific deficit in suppressing processing of task-irrelevant, but salient global shape information (PPC), which leads to increased global precendence with aging

Older, in contrast to younger, participants, could not override the strong saliency signal when it interferred with the task. This **inhibitory deficit of global object salience** might be a distinctive aspect of aging, as top-down control in other tasks is often preserved in older age (Madden, 2007)

Our findings contribute to clarify as yet inconsistent age effects on **hierarchical processing** tasks**:** age differences may depend on the requirement to select lower-salient over higher-salient global-local stimuli (Tsvetanov et al., 2013)

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